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For and on behalf of RWS Group Ltd

The 19th day of September 2006

Feeder with deformable spout

Description

The invention relates to an insert to be inserted into a casting mold which is used for the casting of metals and has a casting cavity, having a body which extends along a body longitudinal axis and has a body cavity, the body being constructed from at least one first shaped body, which has a connecting opening by means of which the body cavity can be connected to the casting cavity, and a second shaped body which is placed onto the first shaped body.

When producing workpieces by casting, liquid metal is poured into a casting mold which has a casting cavity. The casting cavity substantially corresponds to the negative shape of the workpiece to be produced. The casting mold additionally has inlet lines, through which the liquid metal can be conveyed into the casting cavity, and cavities, so-called feeders, which serve as compensating tanks in order to compensate for the volume reduction which takes place when the metal solidifies, and to thus counteract shrinkage cavitation in the cast part. For this purpose, the feeders are connected to the cast part and/or to the endangered region of the cast part, and are usually arranged above and/or at the side of the casting cavity. After the metal solidifies, metal residues remain in the feeder cavities and in the inlet lines, and said metal residues must be removed from the workpiece. Here, the aim is to keep the size of said metal residues as small as possible, and to configure their shape such that said residues can be removed simply and completely, for example by knocking them off.

To produce the casting mold, a pattern plate (or pattern shape) is firstly provided which corresponds to the inner contour of the casting cavity. A holding

device is normally provided at those points at which an inlet line or a feeder insert is to be attached, for example a mandrel for fixing the position of the feeder insert or of the inlet line. After said feeder and inlet lines have been attached to the pattern plate, a mold material, usually molding sand, is applied to the pattern plate such that the feeder insert and the inlet lines are enveloped. In a further step, the mold material is then compressed, so that the feeder and the pre-shaped inlet lines are enclosed by the compressed mold material.

Relatively high compression pressures are used in compressing the mold material. There is therefore the danger that the feeder insert and the further inlet lines attached to the pattern cannot withstand the buckling forces which occur during compression, and therefore break. This can result in difficulties during the casting process when the metal is poured in, and in it no longer being possible to feed the cast part in a controlled fashion.

It has been attempted to counteract said problem by using particularly stable and thick-walled inserts. These are, however, very expensive as a result of the increased material requirements.

Another approach is to absorb the buckling forces which occur during compression molding by means of so-called spring mandrels. Spring mandrels generally comprise a tubular element for fastening to the pattern plate, a spring which is arranged in the tubular element, and a mandrel tip element which rests on the spring and can move telescopically in the longitudinal direction. After the spring mandrel is fastened to the pattern plate, a feeder insert is placed on, the lower face of said feeder insert being situated at a certain distance from the pattern surface in the initial arrangement, that is to say before the mold material is poured in.

When the mold material is subsequently filled in and compressed, the feeder insert is moved, counter to the spring force exerted by the spring mandrel, in the direction of the pattern surface, without the underside of the feeder insert coming into direct contact with the pattern surface. Destruction of the feeder insert is therefore prevented even when high compression forces are used.

DE A 41 19 192 A1 describes a spring mandrel for holding feeders, said spring mandrel comprising a holding and guiding part, a spring and an axially moveable casing. The casing is pot-shaped and engages over the spring and the holding and guiding part.

DE 195 03 456 C1 describes an arrangement comprising a pot-shaped feeder and a mandrel which serves to mount said pot-shaped feeder on a casting pattern with a spacing from the surface of the latter. A first and a second rigidly predefined stop for a first and a second spacing position are predefined on the mandrel. The feeder moves into the second spacing position, which is close to the surface of the casting pattern, when the molding sand is compressed, by virtue of a predetermined breaking point being opened in the base of the feeder as a result of the counterforce from the mandrel, as a result of which the feeder can move into the second spacing position.

The spring mandrels must initially be fastened to the pattern plate before the feeder inserts are inserted, though this is laborious. It is also difficult to obtain a precisely arranged knocking-off edge when using a spring mandrel. Said knocking-off edge is provided in order to make it possible to separate the feeder residue, that is to say the material which remains in the feeder after the casting process, from the cast part. The cleaning expenditure is therefore generally very high. Spring mandrels are additionally

very expensive and are subject to wear.

In order to avoid the use of spring mandrels, two-part feeder inserts have been developed, in which the two shaped bodies can be pushed towards one another as the mold material is compressed, and the forces introduced into the feeder can be dissipated in this way. DE 100 39 519 A1 describes a feeder insert which comprises at least two shaped elements which can be displaced into one another along a feeder longitudinal axis, said shaped elements enclosing a hollow space for holding liquid metal. Holding elements can be arranged on the first and/or second shaped element, the first shaped element supporting the second shaped element by means of said holding elements, and said holding elements being detachable or deformable such that it is possible to displace the two shaped elements into one another along the feeder longitudinal axis.

The invention is based on the object of providing an insert to be inserted into a casting mold which is used for the casting of metals and has a casting cavity, which insert can, without being destroyed, absorb or withstand the forces which occur as the mold material is compressed, and said insert being simple and favorable to produce. It should also be possible at least in the case of one preferred embodiment of the feeder insert to provide a knocking-off edge which makes it possible to precisely detach, for example, a feeder residue from the cast part.

Said object is achieved by means of an insert having the features of patent claim 1. Advantageous embodiments are the subject matter of the dependent claims.

The insert according to the invention, which is to be inserted into a casting mold which is used for the casting of metals and has a casting cavity, has a body

which extends along a body longitudinal axis and has a body cavity. The body firstly comprises at least one first shaped body which has a connecting opening by means of which the body cavity can be connected to the casting cavity. At the opposite side from the connecting opening, the first shaped body has a second opening. The body also comprises a second shaped body which is placed onto, or adjoins, the first shaped body on the side of the second opening. According to the invention, the first shaped body is embodied here as an energy-absorbing device. In the insert according to the invention, the forces which are exerted on the insert as the mold material is compressed are thus absorbed by the first shaped body, and the energy which is introduced is thereby dissipated. This can occur, for example, by virtue of the first shaped body breaking or splintering. It is however preferred for the energy to be absorbed through deformation of the first shaped body.

For this purpose, in a particularly preferred embodiment, it is provided that the first shaped body has, or constitutes, a deforming element.

The deforming element can be designed in a variety of ways. For example, the first shaped body can be tubular, with the second shaped body being placed on its upper side. If a force is exerted in the direction of the longitudinal axis of the shaped body or in the direction of the body longitudinal axis, the second shaped body can be displaced in the direction of the longitudinal axis towards the pattern plate. The deforming element can, for example, be placed around the first, lower shaped body in the manner of a sleeve which is supported, for example, on the face of the pattern, on an abutment which is provided on the outside of first shaped body, or on the base of a spring or centering mandrel. In said embodiment, the first shaped body thus comprises a deforming element

which is arranged separately from said mandrel. As the mold material is compressed, the second shaped body is initially moved down until it comes into contact with the upper end of the deforming element. If the second shaped body is then moved further in the direction of the pattern plate, this leads to deformation of the deforming element. Energy is absorbed as the deformation takes place, with the parameters of the deforming element being selected such the second shaped body is not destroyed as a result of the forces which act during compression.

In another embodiment, it is provided that the deforming element forms an integral constituent of the first shaped body. In order to allow the forces which act on the insert as the mold material is compressed to be introduced into the first shaped body, it is preferably provided that the second shaped body is supported on the first shaped body. As the mold material is compressed, the second shaped body therefore does not move along the longitudinal axis over the first shaped body, but rather compresses the latter such that it buckles. There is therefore preferably a rigid connection between the second and first shaped bodies, so that the forces can be introduced from the second shaped body into the first shaped body efficiently.

The first shaped body is preferably designed such that it can be completely deformed. The forces which are exerted on the first shaped body as the mold material is compressed then lead to buckling of the first shaped body, resulting in the walls of the first shaped body being deformed or bent.

The first shaped body is preferably designed such that the outer envelope has a substantially tubular or bowl-shaped design. Here, a tubular design is to be understood as a cylinder whose cross section can also,

however, reduce in size in the direction of the connecting opening, so that a narrowing section adjoins a cylindrical section. A bowl-shaped design is to be understood as a shape in which the outer periphery of the first shaped body, proceeding from the side at which the second shaped body can be placed on the first shaped body, decreases in size towards the side of the connecting opening in the direction of the body axis. Depending on the degree with which the outer diameter decreases, the result is a bulging or funnel-shaped design. An envelope is to be understood as a face which connects the outermost points of the first shaped body.

As the mold material is compressed, the second shaped body should move substantially only along the body longitudinal axis in the direction of the pattern plate. Here, it is particularly important to prevent the body longitudinal axis from tilting away from the perpendicular relative to the pattern plate, and to thus prevent that the position of the insert or of the body cavity in the finished casting mold can no longer be controlled. The first shaped body is therefore preferably designed so as to allow controlled buckling. In a preferred embodiment, predefined bending points are therefore provided in the wall of the first shaped body. Said predefined bending points can, for example, be generated by forming grooves in the wall of the first shaped body. If, for example, the first shaped body is composed of sheet steel, depressions can be impressed along the periphery of the first shaped body, so that the first shaped body has a reduced wall thickness at these points. The surface of the first shaped body also receives a slightly non-uniform structure as a result of the impressing process. If pressure is then exerted on the first shaped body in the direction of the body longitudinal axis, said first shaped body bends at the predefined bending points, and is deformed in a controlled way.

It is preferably provided that the deforming element is embodied as a type of bellows. The bellows comprises individual segments which are preferably already arranged inclined relative to the body longitudinal axis. Corresponding predefined bending points can however also be provided, for example by means of a reduced wall thickness at the corresponding points of the first shaped body. It is particularly preferable for at least two predefined bending points to be provided, one below the other, in each case annularly along the periphery of the first shaped body. When a force acts on the body as the mold material is compressed, said force running along the body longitudinal axis or along the perpendicular relative to the pattern plate, the bellows is pressed together in the manner of an accordion. As a result, it is possible to make up for the volume reduction of the casting mold which is caused by the compression of the mold material. The bellows can also absorb energy which is introduced in that it is produced from a material which is deformable and provides a certain resistance to the deformation.

The bellows comprises individual segments, with a bend (or a predefined bending point, cf. above) being formed at each connection between said segments. Before being compressed, the segments are preferably each inclined at an angle of 0° to 80° relative to the body longitudinal axis, preferably 5° to 60°, in particular 15° to 50°. This makes it possible for the bellows to be pressed together uniformly in a controlled way.

The bellows can, for example, be of tubular or bowl-shaped design. In the case of a tubular bellows, the first shaped body has the same diameter at each of the bend points, resulting in a tubular envelope if the bends each define an outer face. In the case of a bowl-shaped design, the diameter of the first shaped body decreases in a stepped fashion at each of the bend

points. If the magnitude of the decrease between two bends is constant in each case, the result is a funnel-shaped envelope if the bends are connected by a face. If the magnitude with which the diameter decreases at each of the bend points increases, the result is an envelope with a more bulging shape.

The segments are also preferably dimensioned such that the the extent of the segments between bends of the bellows is between 0.1 and 30%, preferably between 1 and 20%, of the extent of the bellows in the direction of the body longitudinal axis, preferably between 1 and 10%.

In the case of the above described bowl-shaped embodiment of the bellows, which leads to the bellows having a stepped shape, the bellows which acts as a deforming element preferably comprises less than 5 steps. Here, a step is formed in each case from two segments, one preferably being arranged parallel to the body axis and one preferably being arranged perpendicular to the body axis. Here, the steps can each have the same height or the same extent perpendicular to the body longitudinal axis. In one embodiment of the insert according to the invention, however, the steps of the bellows have different heights in each case, with the step arranged closer to the connecting opening having a greater height than the steps arranged closer to the second opening. The step arranged next to the connecting opening preferably has the greatest height of the steps. The height of the steps corresponds to the extent of those segments which are arranged parallel to the body longitudinal axis. In one embodiment of the invention, the extent of the segments arranged perpendicular to the body longitudinal axis increases from the side of the second opening towards the side of the connecting opening. The profile of the deformation of the first shaped body can therefore be controlled.

In one embodiment of the invention, the extent of the bellows in the direction of the body longitudinal axis is between 20 and 80% of the height of the first shaped body or deforming element. The height of the first shaped body corresponds to the maximum extent of the first shaped body in the direction of the body longitudinal axis.

A design of the deforming element in the shape of a bellows is certainly preferred. However, other designs of the deforming element are also possible. For example, individual depressions, bends or openings can be provided in the material of the first shaped body, said depressions, bends or openings allowing controlled buckling of the first shaped body. If, in particular, the deforming element is embodied as a sleeve which is arranged around the first shaped body, it is possible for example to produce the sleeve from a holed material, for example a holed sheet metal strip. The formation of holes reduces the stability of the strip, so that, when pressure is exerted on the strip in the direction of its plane, said strip is pressed together in a controlled manner as it is deformed. Since no molding sand may pass into the body cavity, an embodiment in conjunction with a first shaped body is expedient in which the body cavity is sealed off from the surrounding sand.

The first shaped body is preferably formed from an irreversibly deformable material. With such a design, energy which is introduced as the first shaped body is buckled can be absorbed and dissipated. There are a wide range of suitable materials for producing the first shaped body. The first shaped body can be produced from cardboard, such as corrugated cardboard, plastic, for example polymer foam such as polystyrene foam, wood, composite materials, for example fiber-reinforced plastics or metal/plastic composite

materials.

According to a further embodiment, the first and second shaped bodies can also be connected to one another, for example by means of an adhesive connection. It is however also possible for the first and second shaped bodies to be formed together in one piece.

It is particularly preferable, however, for a metal to be used as the deformable material, with sheet steel being particularly preferred here. Aluminum-containing materials or magnesium-containing materials, for example, are also possible. It is easily possible to shape metals, in particular steel, into almost any desired design. Said metals are irreversibly deformable and can absorb force and therefore dissipate energy during deformation. Here, the properties of the first shaped body can be varied within wide ranges by means of, for example, the wall thickness or the type of metal or steel used.

It is particularly preferable for a steel to be used which has a carbon content of at least 0.05% by weight, preferably at least 0.07, preferably at least 0.1% by weight and particularly preferably at least 0.12% by weight. Steel has a higher melting point than cast iron. If the insert according to the invention is used for casting cast iron, the first shaped body which is manufactured from steel therefore does not melt immediately on contact with the liquid iron. The steel sheet initially softens, and subsequently slowly dissolves into the cast iron flowing out of the feeder insert. Since steel has a lower carbon content than cast iron, the carbon contained in the cast iron is reduced in concentration in those regions of the cast piece which adjoin the first shaped body. This results in an increased tendency towards shrinkage cavitation in said regions. The measure according to the invention of increasing the carbon content of the steel reduces

said effect of a reduction in concentration, and shrinkage cavitation is therefore suppressed. The carbon content of the steel is preferably as high as possible. In order to still ensure sufficient deformability in particular during production of the first shaped body, for example by means of deep drawing, the carbon content is, however, preferably less than 0.7% by weight, preferably less than 0.6% by weight.

A further preferred material for producing the first shaped body is cardboard, wood or wood composites. Said materials burn on contact with the liquid metal, though with little observed gas generation. However, in said embodiment of the first shaped body, a spring mandrel is preferably used for fastening the insert according to the invention to the pattern, since cardboard can only absorb small quantities of energy as it deforms.

The wall thickness of the first shaped body is suitably selected as a function of the material used. The wall thickness is preferably between 0.1 and 3mm, particularly preferably 0.2 to 1.5mm. When using sheet steel, the wall thickness is preferably in the range from 0.1 to 1.5mm, particularly preferably 0.2 to 0.8mm. When using cardboard, wood or plastics, the wall thickness is preferably 0.1 to 3mm, preferably 0.5 to 1.5mm.

In order to be able to easily detach metal residues, which remain in the cavities of the inserts after the casting process, from the workpiece, the first shaped body preferably narrows in the direction of the connecting opening. After the casting mold has been removed, the workpiece then has a constricted portion at said point. This makes it possible to accurately and simply knock off the metal residues, and considerably reduces the cleaning expenditure.

As already explained above, in one embodiment of the insert according to the invention, the forces which act on the second shaped body as the mold material is compressed should be introduced into the first shaped body and dissipated there through deformation of the first shaped body. This avoids damage to the second shaped body. In order to make it possible for the forces acting on the second shaped body to be completely and uniformly introduced into the first shaped body, it is provided in a preferred exemplary embodiment that the first shaped body has an annular support face for supporting the second shaped body.

The insert according to the invention can be placed directly on the pattern plate by virtue, for example, of the connecting opening provided on the first shaped body being designed in such a way that it is possible for the insert to be reliably fixed to the pattern plate. In order to prevent the body tipping as the mold material is poured in and compressed, it can however be expedient to provide a centering mandrel onto which the insert according to the invention is placed. In one embodiment of the insert according to the invention, it can be provided here that the second shaped body has a centering recess for holding a centering mandrel.

The insert according to the invention can be formed in any desired way and can, for example, in the finished casting mold, form an inlet line for the liquid metal into the casting mold cavity. The term "insert" is therefore intended to encompass any element, such as sleeves, funnel or filter elements, or feeders and the like, which can be integrally formed in or on the casting mold or pattern. The advantages of the insert according to the invention are shown to particular advantage when the insert is embodied as a feeder insert.

The invention is explained in more detail in the following with reference to the appended figures, in which:

Figure 1: shows a longitudinal section through an insert according to the invention, said insert being embodied as a feeder insert;

Figure 2: shows a longitudinal section through an embodiment of the first shaped body, with the latter being of tubular design;

Figure 3: shows a longitudinal section through an embodiment of the first shaped body, with the latter being of bowl-shaped design.

Figure 1 shows a longitudinal section through an insert according to the invention, said insert being embodied as a feeder insert. The illustration shows a state as encountered after the feeder insert has been mounted on the pattern plate but before the mold material has been poured in. A spring mandrel 2 is fastened to a pattern plate 1, with a feeder insert 3 according to the invention being placed over said spring mandrel 2. The body of the feeder insert 3 comprises a first shaped body 4 and a second shaped body 5. The first shaped body 4 and second shaped body 5 together form a feeder cavity 6 (body cavity) which extends along a feeder longitudinal axis 7 (body longitudinal axis). The first shaped body 4 comprises a section which is embodied as a deforming element 8 and a section 9 in which the first shaped body 4 narrows in the direction of the connecting opening 10. The deforming element 8 is formed in the shape of a bellows and accounts for approximately 60% of the height of the first shaped body 4. The first shaped body 4 can, for example, be made of metal, in particular sheet steel, cardboard or plastic. A second shaped body 5, which is embodied here as a feeder head, is placed onto the first shaped

body 4. Said second shaped body 5 is of pot-shaped design and has an opening 110 at its lower end, said opening producing a connection to the interior space of the first shaped body 4 in order to form the feeder cavity 6. The second shaped body 5 is made from a fire-resistant material and can have insulating or exothermic properties. The second shaped body 5 is produced from those materials which are conventional for feeders, for example sand, fibers or mineral hollow spheres which are connected by means of a suitable binding agent such as water glass. In order to provide the feeder with exothermic properties, said material can, for example, also have added to it an oxidizable metal, for example aluminum or magnesium, and an oxidizing agent, for example saltpeter. The wall thickness of the first shaped body 5 is selected to be in the conventional range for feeders, so that any desired insulating properties and the required mechanical stability is obtained. The second shaped body 5 can be produced using feeder production methods which are familiar to a person skilled in the art.

The first and second shaped bodies 4, 5 can, for example, be connected to one another by means of an adhesive connection and can be regarded as a completed feeder. It is however also possible for the first shaped body 4 and second shaped body 5 to be mounted separately and only to be brought together in the production of the casting mold. In the embodiment illustrated in figure 1, a spring mandrel 2 is provided in order to fix the feeder element 3 in its position and to prevent it from tipping. It is not strictly necessary to use a spring mandrel to fix the position of the feeder insert 3. It is also sufficient, for example, to provide a centering mandrel. The latter runs substantially along the feeder longitudinal axis 7 in order to then break through the upper wall of the second shaped body 5. For this purpose, a centering opening (not illustrated) can correspondingly be

provided in the second shaped body 5 at the upper side, through which centering opening the centering mandrel can be guided. It is also possible to dispense with the use of a mandrel entirely. This, however, increases the danger of the feeder being tipped such that it is no longer perpendicular when the mold material is poured in and when the latter is compressed.

Figure 2 illustrates a longitudinal section through the first shaped body 4 of the feeder insert according to the invention. Said feeder insert comprises a section 8 which is embodied as a deforming element and whose extent 11 in the direction of the feeder longitudinal axis 7 corresponds to approximately 60% of the height 12 of the first shaped body 4. An annular support 13 is provided at the upper end of the first shaped body 4, on which annular support 13 the second shaped body 5 (not illustrated) can be placed, the latter enclosing the second opening 110. Below the section 8, a section 9 is provided in which the first shaped body narrows in the direction of the connecting opening 10. The deforming element 8 is embodied as a bellows which comprises individual segments 14. A bend 15 is provided at each connection between the individual segments 14. Connecting the outer bends 15a results in a tubular design of the envelope 21.

In figure 2, the first shaped body is illustrated in a state as is encountered before the mold material is compressed, that is to say before the first shaped body is buckled in order to absorb energy. Here, the individual segments 14 enclose an angle 16 relative to the feeder longitudinal axis 7 of between 0° and 80°, preferably between 30° and 60°, particularly preferably between 30° and 50°. Here, the extent 17 of the segments 14 is selected such that it corresponds to between 1 and 10% of the extent 11 of the bellows in the direction of the body longitudinal axis 7. Skirts

18 may be provided on the support 13 at the outer edge, said skirts 18 facilitating the centering of the second shaped body 5. It is likewise possible for skirts 19, 20 to be provided at the edge of the connecting opening 10, said skirts 19, 20 facilitating centering of the first shaped body 4 in an opening of the pattern plate (not illustrated).

Figure 3 illustrates an embodiment of the first shaped body, with the latter having a bowl-shaped envelope 21.

In the embodiment illustrated in figure 3, the diameter of the first shaped body 4 decreases from the side of the second opening 110 towards the side of the connecting opening 10 in a stepped fashion at the points of the bends 15. If the outer bends 15a are joined up to form an enveloping face 21, the latter has a bowl-shaped design.

Here, the height of the segments 14a arranged parallel to the longitudinal axis 7 increases in the direction from the side of the second opening 110 to the connecting opening 10, that is to say in the illustration from top to bottom. The extent of the segments 14b arranged perpendicular to the longitudinal axis 7 likewise increases from the side of the second opening 110 to the side of the connecting opening 10. The extent of the segments arranged perpendicular to the longitudinal axis 7 corresponds to the spacing between the segments 14a, arranged parallel to the longitudinal axis, which adjoin them at both sides in each case.

That side of the first shaped body 4 which has the connecting opening 10 is placed on a pattern. The second shaped body (not illustrated), such as for example a feeder head which has exothermic or insulating properties, is placed on the opposite side which has the second opening 110. The first shaped

body 4 is preferably composed of steel which has a high carbon content.

The feeder insert according to the invention allows the forces which act on the feeder element 3 as the mold material is compressed to be absorbed through irreversible (inelastic) deformation of the first shaped body 4. As a result, breakage or buckling of the second shaped body 5, which is usually composed of a brittle material, can be reliably prevented.